

Astus, a new Western Australian genus of Myrtaceae with heterocarpidic fruits

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Abstract

Trudgen, M.E. and Rye, B.L. *Astus*, a new Western Australian genus of Myrtaceae with heterocarpidic fruits. *Nuytsia* 15(3): 495–512 (2005). *Astus* Trudgen & Rye, a new genus of Myrtaceae with four species endemic to the south-west of Western Australia, is described and its affinities discussed. While the genus is circumscribed on the basis of a range of characteristics that separate it from related genera, all its members are unusual in having a fruit with both dehiscent and indehiscent loculi. In addition, two of the species have a marked heteromorphy in their calyx lobes. *Astus* is one of a number of genera belonging to the tribe Chamelaucieae that have reniform seeds. While the floral morphology of the new genus does not readily indicate which of the other reniform-seeded genera it is closest to, DNA evidence indicates affinities to the Eastern Australian genus *Triplarina* Raf. The type species, *Astus tetragonus* (F. Muell. ex Benth.) Trudgen & Rye, is based on *Baeckea tetragona* F. Muell. ex Benth. *Astus duomilius* Trudgen & Rye, *A. subroseus* Trudgen & Rye and *A. wittweri* Trudgen & Rye are new species. A key to the species, descriptions, illustrations and distribution maps are provided.

Introduction

Four species of Myrtaceae endemic to the south-west of Western Australia are described as a new genus, *Astus*, on the basis of a suite of characteristics that separates them from all other members of the family. The position of *Astus* in the recently redefined tribe Chamelaucieae (Wilson *et al.* 2005), the degree of variation within the genus and its distinction from other genera are discussed.

Most aspects of the morphology of the new genus are well within the range of morphological variation known within the Myrtaceae. This includes characteristics such as leaf size and shape, inflorescence type, stamen number and arrangement, anther type, placentation and ovule number. However, *Astus* is very unusual in that all four species have two distinct types of carpels in the same ovary. These develop into dehiscent and indehiscent loculi in the fruit, with two quite different modes of seed dispersal. This heterocarpidic fruit type does not appear to have been reported previously for the Myrtaceae, but is also known in the *Baeckea robusta* F. Muell. species complex. It is described, illustrated, and discussed in more detail in an accompanying paper (Rye & Trudgen 2005). Not only is this fruit type a very unusual phenomenon for the Myrtaceae, it is apparently extremely rare among the angiosperms as a whole.

Two of the four species placed in *Astus* also have obviously heteromorphic calyx lobes. While some degree of calyx heteromorphism is not unusual in the Chamelaucieae, the degree of calyx heteromorphism present in *Astus* is exceptional.

Taxonomic history and position of *Astus* within the Myrtaceae

The only member of *Astus* described prior to this revision was the type species, *Astus tetragonus*, which was named as *Baeckea tetragona* by Bentham (1867) in his treatment of the Myrtaceae for "Flora Australiensis". In that treatment, *Baeckea s. lat.* was included within the tribe Leptospermeae because it had a dry multi-locular fruit, and the distinguishing characteristics noted for its subtribe Baeckeinae [as Baeckeeae] were the minute cotyledons on the embryo, the opposite leaves and the stamens being shorter than the petals.

Bentham placed *B. tetragona* in *Baeckea* section *Euryomyrtus* (Schauer) Benth., which has since been reinstated as a genus. He noted that the seeds were similar to those of *Baeckea diffusa* Sieber ex DC. (a synonym of *Euryomyrtus ramosissima* (A. Cunn.) Trudgen). Niedenzu (1893) appears to have followed Bentham's sectional concepts, so presumably also included *Baeckea tetragona* among the six species he recognised for section *Euryomyrtus*, although it was not one of the two species he cited as examples of the group.

In their informal classification of the Myrtaceae, Briggs & Johnson (1979) placed the genera of subtribe Baeckeinae in their *Baeckea* suballiance of the *Chamelaucium* alliance. However, in a later paper these authors concluded that their two suballiances for the *Chamelaucium* alliance were unnatural and so abandoned them (Johnson & Briggs 1985). Recent studies based on DNA sequencing have provided evidence that the *Chamelaucium* alliance is a monophyletic group, with the most recent publication resulting from this work (Wilson *et al.* 2005) formally recognising the alliance as a new broad circumscription of tribe Chamelaucieae.

Within the subtribe Baeckeinae, as it was previously recognised, Trudgen (1986, 1987, 2001) distinguished a group of genera that were characterised by having crustaceous reniform seeds, a dehiscent multi-locular fruit and the most common anther type in the Myrtaceae – one with an external connective gland and dehiscence by two parallel slits. He included *Baeckea tetragona* and its allies within this reniform-seeded group, which he regarded as a natural group. The taxa Trudgen (in prep.) now includes in this group are *Astus*, *Cyathostemon* Turcz. (which we intend to reinstate in a subsequent paper), *Enekbatus* Trudgen & Rye ms., *Euryomyrtus* Schauer, *Hypocalymma* (Endl.) Endl., *Ochrosperma* Trudgen, *Rinzia* Schauer, *Triplarina* Raf., and some as yet unplaced species such as *Baeckea crassifolia* Lindl., *Baeckea ericaea* (F. Muell.) Benth. and *Baeckea polystemonea* F. Muell.

The reniform seed, which generally has a relatively large size, non-faceted shape, thick testa, colliculate to tuberculate patterning, and sometimes has an aril, is a key character which appears to be an indication of a monophyletic group, although further studies may extend the boundaries of that group. Given the apparently strong morphological evidence for the reniform-seeded group as a natural entity, it is interesting that it was not clearly defined in two molecular analyses (Lam *et al.* 2002, Wilson *et al.* 2004) of the Chamelaucieae, and that *Astus* was indicated as definitely not belonging within the reniform-seeded group. While several subgroups were supported to some degree in these analyses, based on sequencing of up to four chloroplast regions, the reniform-seeded group as a whole was not, although a significant portion of the overall analysis was largely unresolved.

The relatively small number of species sampled for each genus may partly explain this. Alternatively, the chloroplast regions examined may have either insufficient or too much variation in their sequences to be useful in this portion of the analysis. The current extension of molecular sampling to more species in the Chamelaucieae is at least partly addressing the issue of sample size. Recent sampling of a nuclear DNA region is also resolving some of the problems with the published analyses and now shows *Astus subroseus* coming out closely with two species of *Triplarina* (Peter Wilson pers. comm.).

Calyx lobe heteromorphy in *Astus subroseus* and *A. tetragonus*

Bentham (1867: 77) noted that the two outer calyx lobes (i.e. those that enclose the others and petals in the buds) in "*Baeckea tetragona*" could be "narrower and greener" than the inner ones. However, he did not give any indication of the magnitude of this difference. In fact, the difference is quite marked, with the outer two calyx lobes having a herbaceous centre and being noticeably shorter than the petals, while the others are petaline and almost as long as the petals but narrower. A slightly more pronounced heteromorphy occurs in *Astus subroseus* with a greater difference in size between the outer and inner calyx lobes (Figure 2D,I). In contrast, *Astus duomilius* and *A. wittweri* have uniformly sized calyx lobes, all far smaller than the petals and all with a herbaceous centre and scarious edges.

It is fairly common for the outer two calyx lobes to be more herbaceous than the inner ones in the Chamelaucieae, as the outermost ones have a protective function in the buds. It is also common for the inner calyx lobes to be somewhat broader than the outer ones and to have larger numbers of stamens opposite them, as occurs in two of the *Astus* species. However, such a marked heteromorphism in the calyx lobes as found in these *Astus* species has not been observed in any other members of the tribe.

The three petaline calyx lobes found in *Astus subroseus* and *A. tetragonus* fill small gaps between the petals, as can be seen from the photograph of the flower of the latter species (Figure 1B). Although this does not alter the diameter of the flowers, it may increase their surface area sufficiently to increase the frequency of visits by pollinating insects. The development of petaline calyx lobes, but of a more uniform size, is also present in a number of other groups of species in the Myrtaceae, even to the extent of the calyx lobes becoming larger than the petals in species such as *Thryptomene calycina* (Lindl.) Stapf. Rather than indicating a close relationship, this appears to be another occurrence of convergent evolution in relatively distant groups within the Chamelaucieae.

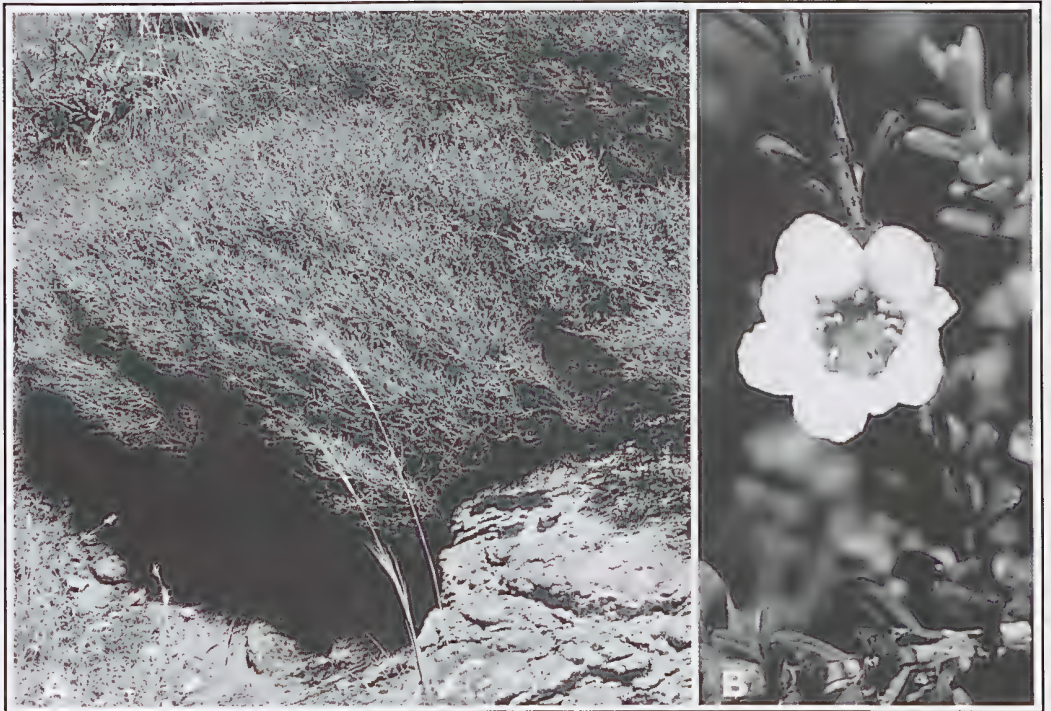


Figure 1. Photographs of *Astus tetragonus* taken at Cape Le Grand by P.J. Rye. A – habit; B – flower.

Distinction of *Astus*

The distinction of *Astus* as a separate genus is based on all four species having a combination of morphological characters that is unique both within the Chamelaucieae and within the Myrtaceae as a whole. Other genera may have some of the characters listed below, but they do not have the entire suite of them. The combination of characters found in *Astus* that distinguishes the new genus from all other genera of Myrtaceae is:

- hypanthium obconic in the flower, slightly longer than broad or up to about 1.3 times longer;
- hypanthium five-angled, without a true rib on the angle, although (particularly in dried material) it may appear ribbed;
- inflorescence a single, shortly pedunculate flower;
- stamens of the (presumed primitive) taxonomically widespread type with a more or less terete filament, free connective gland, and the anthers dorsifixed, versatile and with parallel loculi opening in longitudinal slits;
- ovary multi-locular, fused for all of its length to the hypanthium; disc deeply concave, except for a small convex area at the centre (around the style base);
- ovary walls thin at the flowering stage, only thickening slightly in the fruit;
- ovary loculi of two types: the type that becomes dehiscent in fruit having a broad summit where the valve forms, the other type (indehiscent in fruit) being broader towards its base and positioned somewhat lower in the ovary;
- fruit a derivative of a capsule, usually with two dehiscent and one indehiscent loculi, fused for its length to the hypanthium and enclosed by it except at the top, the ovary expanding upwards;
- the hypanthium remaining obconic and five-angled in the fruit (although there may be bulges around individual loculi);
- dehiscent loculi not opening very widely, with the valves not much thickened;
- seeds reniform, with a crustaceous testa, colliculate, moderately large, with no aril.

Astus is easily distinguished from the other reniform-seeded members of the Chamelaucieae by a combination of characters relating to the hypanthium. In *Astus*, the hypanthium is obconic, five-angled, thin (especially in the fruit) and somewhat longer than broad. In the flowering stage the whole length of the ovary is fused to the hypanthium, so that only the top of the ovary is free, although in the fruiting stage, some expansion of the loculi at their summit (the top of the valves) occurs, resulting in a greater proportion of the fruit being free from the hypanthium.

Also important in distinguishing *Astus* are seed characters, such as the lack of an aril, and fruit characters. The valves of the fruit are not very thick and do not open particularly widely, in contrast to genera such as *Rinzia* and *Euryomyrtus*, where the fruit has thicker valves and opens very widely.

While the partially indehiscent fruit of *Astus* species undoubtedly adds significantly to the distinction of the genus, the four species referred to *Astus* would still be substantially different from related genera and still deserve generic status if they had only dehiscent loculi. The intriguing fruit type of *Astus* probably evolved after the genus separated from other genera.

Comparisons of *Astus* to related genera

In the reniform-seeded group there is wide variation between the genera in stamen arrangement, the degree of fusion of the ovary to the hypanthium and other characters. The distinction of *Astus* as a genus, and its separation from other genera, is therefore perhaps best appreciated by individual comparisons between it and the other genera placed in the group. This has the additional benefit that when *Astus* is compared individually to another genus (or to a small group of genera), significant additional differences are identified that add to the understanding of the differentiation of the new genus.

The stamens of *Astus* are of the widespread type with versatile, dorsifixed anthers and terete filaments with the connective gland free from the filament. These stamens distinguish *Astus* from *Rinzia*, *Hypocalymma* and *Cyathostemon*. *Rinzia* has the anthers fixed to the front of the filaments, i.e. the anthers are dorsifixed, but not versatile, while *Hypocalymma* and *Cyathostemon* have basifixed anthers. While *Astus* and *Hypocalymma* have terete filaments, *Rinzia* and *Cyathostemon* have flattened filaments, but in *Astus* the filaments are free while in the other three genera they are fused (either shortly, or for much of their length). Adding to the separation of *Rinzia*, *Hypocalymma* and *Cyathostemon* from *Astus*, all three have a more or less cup-shaped hypanthium with the capsule free for more of its length and opening more widely. These three genera are quite distinct from *Astus*.

Astus has similar stamens to those of *Euryomyrtus*, and Bentham (1867) evidently considered these two plant groups to be closely related. *Euryomyrtus* differs from *Astus* in its arillate seeds, more rounded hypanthium, broader more widely opening fruit and its rather prominent groups of processes (small finger-like projections) opposite the petals. Processes are also present in *Astus* but are minute and are not united into groups.

The differentiation of *Astus* from *Ochrosperma* is also quite clear. While these two genera have similar stamens and both have the ovary fully or almost fully fused to the hypanthium, the hypanthium is significantly broader than long and not angled in *Ochrosperma* but more elongate (as long, or slightly longer than broad) and five-angled in *Astus*. In *Ochrosperma* the fruit opens fairly widely to widely, the seeds are arillate, and there are 5–8 stamens, with usually one opposite each calyx lobe, but two opposite some calyx lobes in *O. adpressum* A.R. Bean (Bean 1995). In contrast, in *Astus* the fruit does not open widely, the seeds are not arillate, and there are 8–12 stamens, with either 1–3 opposite each calyx lobe or one opposite each petal and calyx lobe.

As *Astus* and *Triplarina* both have the ovary fully fused to the hypanthium and both have seeds without an aril, the differences between them seem somewhat less. However, while *Astus* has 8–12 stamens, either one opposite each petal and calyx lobe or 1–3 opposite each calyx lobe, *Triplarina* has 14–19 stamens, with several opposite each calyx lobe. *Astus* also has larger seeds. The fruit of *Triplarina* is somewhat intermediate between that of *Astus* and that of other genera such as *Rinzia*, but more similar to the latter in its more pronounced development of the valves and greater enlargement upwards after flowering, the hypanthium flattening somewhat in the opened fruit, and the valves opening moderately widely.

A number of species in the reniform-seeded group do not fit in any of the named genera, including *Baeckea crassifolia*, *Baeckea ericaea*, *Baeckea polystemonea* and at least five currently undescribed species. All of these species can be readily separated from *Astus* by their more rounded and broader hypanthium and widely opening fruits that are largely free of the hypanthium. Additionally, these species differ from *Astus* either in having flattened filaments or in their stamen arrangements, and two of them have glandular staminodia as well as normal stamens.

Although *Astus* appears to have significant morphological similarities to each of the other reniform-seeded genera, it is by no means clear which of these genera show the greatest affinities to *Astus*. The molecular data of Lam *et al.* (2002) placed *Astus* closest to a pair of species (*Baeckea corynophylla* F. Muell. and *Baeckea uncinella* Benth.) with a very different morphology, including a quite different type of anther and faceted seeds. However, the recent sampling of the ETS nuclear DNA region now shows *Astus subroseus* coming out within one of the reniform-seeded clades, in close association with two species of *Triplarina* (Peter Wilson pers. comm.).

Given the clear differentiation of the new genus from each of the other genera of the Chamelaucieae with reniform seeds, and the unusual fruit type that the members of *Astus* have, we conclude that *Astus* is a distinctive new genus easily deserving generic status. While the closeness of the relationship of the new genus to other genera in the reniform seed group is not immediately clear, the similarity of the fusion of the ovary to the hypanthium in *Astus* and *Triplarina* and the indication from DNA studies that these genera may be close is an intriguing possibility given the disjunction between them.

Heterogeneity in *Astus*

The four members of this genus fall into two distinct pairs of species, which are compared in Table 1. The first pair, referred to here as the typical pair, consists of the type species *Astus subroseus* and *A. tetragonus*. These two species are very similar in morphology and clearly very closely related to one another. The other two species, *A. duomilius* and *A. wittweri* are also closely related to each another but not to the same degree as the members of the typical pair. They differ from the typical pair in having caducous rather than persistent bracteoles, a regular arrangement of the stamens opposite the calyx lobes and petals, floral processes opposite the petals rather than the calyx lobes, and uniformly small non-petaline calyx lobes rather than heteromorphic calyx lobes.

While these differences suggest that the two pairs of species have been separated for some considerable time, we do not consider them to justify the recognition of two separate genera. The characters that unite *Astus* and differentiate it from the other genera in the reniform-seeded group, especially the relatively narrow, five-angled hypanthium and the heteromorphic carpels, appear to us to be more important. Consequently, *Astus* is accepted here as a genus of significant antiquity, and which has a range of morphology reflecting that antiquity. In a larger genus, the differences listed would justify erecting subgenera or sections.

Seed development and insect associations

The properly developed seeds found in indehiscent loculi of *Astus* species have the same morphology as those developed in dehiscent loculi. Such seeds are similar to the reniform seed type found in genera such as *Rinzia*, *Euryomyrtus* and *Hypocalymma*. Seeds of three *Astus* species are illustrated in the accompanying paper (Rye & Trudgen 2005).

However, as well as normal seeds, galled seeds are developed in at least two *Astus* species as the result of parasitism of ovules by a minute insect larva. Such "seeds" develop a shape and testa morphology quite unlike that of normal seed. Rather than developing the normal reniform shape, galled seeds are more irregular and commonly subglobular. A galled seed is illustrated (Figure 2F) for *A. subroseus*; this is deeply colliculate around the hilum and more reticulate elsewhere. Showing the

Table 1. Morphological differences between the two pairs of species in *Astus*.

Character	<i>A. duomilius</i> and <i>A. wittveri</i>	<i>A. subroseus</i> and <i>A. tetragonus</i>
bracteoles	caducous	persistent
bud apex		
lobes	not very prominent	prominent
centre	highly raised	concave to flat
calyx lobes		
hetermorphism	absent	present
texture	mostly herbaceous	mostly petaline
stamen number		
opposite each calyx lobe	1	1-3
opposite each petal	1	0
processes	opposite petals	opposite calyx lobes

variability in galled seeds, one illustrated (Figure 2K) for *A. tetragonus* is reticulate. The larvae apparently remain within one ovule, as normal and galled seeds have been observed to develop within the same fruit.

Development of galled seeds has been observed in *Astus subroseus* and *A. tetragonus*. While no galled seeds have been observed in *A. duomilius* and *A. wittveri*, this may be due to the fact that relatively little material of these two species has been available for study.

Distribution and habitat range

Astus is restricted to an area of the South West Botanical Province and South-western Interzone of Western Australia as defined by Beard (1980). It occurs along the coast from just east of Albany to Point Culver on the Great Australian Bight and inland to Wyalkatchem and east to near Coolgardie. The distributions of the four species, presented in Figure 3, are plotted on maps marked with the interim biogeographic (IBRA) regions of Thackway & Creswell (1995) which correspond fairly closely to Beard's (1980) botanical districts. The distribution of *Astus* as a whole is quite similar to that of the much larger genus *Cyathostemon*, but does not extend as far to the north-west.

Three *Astus* species are found on or near the south coast, predominantly in the Esperance biogeographic region. *Astus tetragonus* occurs through much of this region, associated mostly with granitic rocks, but is absent from the far western and far eastern parts of this region. *A. duomilius* occurs within the range of *Astus tetragonus*, but prefers a quite different habitat, being known from only one locality on a sand dune next to a saline lake. *Astus wittweri* occurs east of *Astus tetragonus*; and is known only from Mt Ragged, where it is associated with gneissic (granitic) rocks, and Point Culver.

In contrast to these three species, *Astus subroseus* has a more inland distribution, occurring over a quite large area in the Avon, Mallee and Coolgardie biogeographic regions. It is well separated from the other taxa except where it approaches the range of *A. tetragonus* near Ravensthorpe. In that region, *A. tetragonus* occurs associated with some granitic outcrops east and south of Ravensthorpe while *A. subroseus* has been recorded from lateritic soil north of Ravensthorpe.

It can be seen from the ranges described above that the three *Astus* species that are often or sometimes associated with rocky habitats have more or less parapatric ranges. They show a pattern of geographic 'replacement', that is the species occupy similar habitat (at least for the geological component of habitat) with *Astus tetragonus* occurring immediately to the south of where the range of *A. subroseus* ends and immediately to the west of the known range of *A. wittweri*.

An intriguing aspect of the habitat preferences of the new genus is that there are some similarities to the habitat preference of the eastern Australian genus *Triplarina*, which also tends to occur in sheltered or relatively damp sites such as near the bases of granite outcrops (Bean 1995).

Description of the new genus

***Astus* Trudgen & Rye, gen. nov.**

Frutices glabri. Folia opposita, decussata, parvula. Flores solitarii in axillis foliorum positi, bracteolis paribus oppositis ad juncturam pedunculi cum anthopodio. Hypanthium costis 5 sepalis oppositis. Sepala 5, in fructu persistentia. Petala 5, ungue basali brevi. Androecium ex staminibus 8–12 in unum verticillum dispositis; stamina aequidistantia sepala et petala opposita vel inordinata 1–3 in quoque sepalo opposita et processibus filiformibus parvis sepalis vel petalis oppositis; filamenta filiformia; antherae dorsifixae, versatiles, cellulis parallelibus longitudinaliter dehiscentibus, connectivo in glande plus minusve globulari terminanti. Ovarium 2–4-loculare, cellulis (1)2–7-ovulatis; placentae axiales, peltatae. Styli basis in depressione inserta. Fructus siccus, plerumque loculis valvatis 2 et loculo nonvalvato unico, pariete satis tenui, coriaceo-crustaceo. Semina reniformia; arillus carens.

Typus: Astus tetragonus (F. Muell. ex Benth.) Trudgen & Rye

Shrubs small or medium-sized, glabrous. *Leaves* opposite, decussate, appressed to widely spreading, entire, petiolate; lamina very small, very narrowly obovate to obovate or rarely elliptic in outline, somewhat to very thick, with prominent oil glands, abaxial surface convex to very deeply convex, adaxial surface shallowly concave to shallowly convex. *Flowers* in 1–8(15) decussate pairs clustered at tips of branchlets, solitary in leaf axils, fairly erect, with two opposite bracteoles located at the junction of the peduncle and the anthopodium. *Bracteoles* subulate to broadly ovate, with a herbaceous keel and scarious margins, somewhat folded inwards, acute. *Hypanthium* obconic or broadly obconic, (4)5-

angled, the angles opposite the centres of the calyx lobes and sometimes appearing to be somewhat ribbed, especially when dried. *Calyx* lobes (4)5, all or the outer ones with an incurved herbaceous keel, persistent in fruit. *Petals* (4)5, widely spreading, scarcely clawed, more or less circular, white to medium pink or purplish pink, deciduous in fruit. *Stamens* 8–12, usually 10, inserted singly (not in bundles), either equidistant and one opposite each petal and each calyx lobe, or irregularly arranged with 1–3 opposite each calyx lobe; processes opposite either the calyx lobes or the petals, filiform, small. *Filaments* curved inwards, reaching about the same level as the stigma, often with the base broad and flattened, almost terete above, tapering towards apex. *Anthers* dorsifixed, slightly longer than wide; thecae parallel, opening in full-length slits; connective gland prominent, globular or broadly obovoid. *Ovary* adnate to hypanthium, usually 3-locular but appearing 2-locular from above, with one of the loculi somewhat more basal than the others, the lower loculus differently shaped and sometimes reduced in size; placentas axile, peltate, elliptic to circular, not obviously stalked; ovules up to 7 per loculus, either inserted in a horseshoe shape or in 2 rows, but variable in number with occasional loculi sometimes having as few as 1 ovule or none, more or less reniform, often 2-toned. *Style* fairly stout, slightly tapering towards stigma, base inserted in a narrow cavity; stigma peltate or capitate, more or less circular from top view. *Fruit* multi-locular, dry, usually with 2 valvate loculi and 1 non-valvate loculus, fairly thin-walled, leathery-crustaceous, summit hidden (from side view) within the free portion of hypanthium, apparently with a maximum of one seed produced in each loculus or a maximum of 1 seed per fruit; hypanthium more or less hemispheric to almost obconic; valvate loculi usually 2, broadest across the width of the terminal valve; non-valvate loculus entirely below the level of the valves of the dehiscent loculi but considerably overlapping with them. *Seeds* reniform, 1–1.6 mm long; testa minutely colliculate (with numerous convex cells), pale to medium brown, somewhat shiny; hilum very small, situated on a ridge-like area across the inner part of the seed; aril absent. *Chaff pieces* soft or somewhat crustaceous.

Size and distribution. A genus of four species restricted to the South West Botanical Province and South-western Interzone of Western Australia. Figure 3 shows the distribution of members of the genus.

Etymology. From the Latin *astus* – craft or cunning, referring to the strategy of having two kinds of diaspores and so presumably enhancing the chances of successful recruitment.

Key to species

1. Leaves not or scarcely keeled. Bracteoles caducous. Calyx lobes all very reduced. Stamens equidistant, opposite the calyx lobes and petals
2. Leaves 0.6–0.7 mm wide, about as wide as thick. Anthopodium 0.5–0.7 mm long. Flowers c. 6 mm diam. (Mt Burdett area) **A. duomilius**
2. Leaves 1.2–1.6 mm wide, much wider than thick. Anthopodium 1.5–2 mm long. Flowers 7.5–9 mm diam. (Mt Ragged to Point Culver) **A. wittweri**
1. Leaves with an obvious keel especially towards apex. Bracteoles persistent. Calyx lobes varied in size, the largest ones petal-like. Stamens irregularly spaced, with 1–3 opposite each calyx lobe
3. Young leaves with 2 or 3 rows of prominent oil glands on each side of midvein. Corolla white or very pale pink. (Cape Riche to Cape Arid National Park) **A. tetragonus**
3. Young leaves with 1 row of prominent oil glands on each side. Corolla pale to medium pink or purplish pink. (Wyalkatchem to Coolgardie to Ravensthorpe) **A. subroseus**

Astus duomilius Trudgen & Rye, *sp. nov.*

Folia latitudine circa longitudine aequantia. Bracteolae caducae. Sepala plus minusve aequaliter redacta. Stamina 10, sepalis et petalis opposita.

Typus: E of Mt Burdett [precise locality withheld], Western Australia, 14 Oct. 2000, G.J. Keighery & N. Gibson 5005 (*holo*: PERTH 06691544; *iso*: MEL).

Illustration. Rye & Trudgen (2005: Figure 1A).

Shrub size not recorded, with short leafy branchlets on long stems, the leaves mostly widely antrorse to patent, crowded on the branchlets, mostly shed on lower stems. *Petioles* *c.* 0.6 mm long. *Leafblades* very narrowly obovate in outline, 3–3.5 mm long, 0.6–0.7 mm wide, about as thick as wide, apex obtuse; abaxial surface very deeply convex, with *c.* 7 rows of prominent oil glands with *c.* 6 glands per row; adaxial surface shallowly convex to shallowly concave, with fewer rows of oil glands but the glands similar in size and separation to those on abaxial surface. *Inflorescence* usually of 1 or 2 pairs of flowers clustered at tip of each branchlet. *Peduncles* 0.4–0.5 mm long. *Bracteoles* caducous, not seen. *Anthopodium* 0.5–0.7 mm long. *Buds* 5-lobed around a concave to flat apex. *Flowers* 5-merous, *c.* 6 mm diam. *Hypanthium* obconic or broadly obconic, *c.* 2.8 mm long, *c.* 2.5 mm diam., glandular but scarcely rugose; free portion 0.6–0.8 mm long. *Calyx lobes* 5, all of a similar size, very depressed, 0.5–0.7 mm long, 1.2–1.6 mm wide, strongly incurved at apex, with a very thickened herbaceous base and a scarious margin, the base keeled and reddish. *Petals* 5, widely spreading, scarcely clawed, subcircular, *c.* 2 mm long, white. *Androecium*: stamens 10, one opposite each petal and calyx lobe, the antipetalous ones with a filament *c.* 0.7 mm long, the antisepalous ones tending to be slightly shorter; processes few or absent, opposite the petals, minute. *Anthers* *c.* 0.35 mm long; connective gland *c.* 0.1 mm diam. *Ovary* 3-locular, the indehiscent loculus reduced in size; ovules in two valvate loculi 2–4 (usually 3), in non-valvate loculus solitary, uniformly coloured or sometimes somewhat 2-toned. *Style* *c.* 1.5 mm long; stigma peltate, 0.3–0.35 mm diam. *Fruit* usually heart-shaped in outline, *c.* 2.5 x 2 mm, with summit prominently 2-lobed, each lobe corresponding with one of the 2 valvate loculi, but occasionally with one of the valvate loculi aborted and only one valve developed, the non-valvate loculus of a similar volume but more compressed, the remainder of the fruit (at the base and extending slightly up one side) with an open reticulum of spongy tissue; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; lobes *c.* 0.7 mm high; hypanthium broadly obconic-obovoid, glandular but without obvious ribs. *Seeds* straightened-reniform or slightly obovoid-reniform, 1.4–1.5 mm long, 0.6–0.7 mm wide and thick (slightly thicker than wide), yellowish brown; hilum *c.* 0.3 mm long.

Distribution and habitat. Endemic to Western Australia, recorded from a single locality south of Kau Rock with orange sand on a gentle slope of a lake dune, in a somewhat saline habitat, associated with some species such as *Darwinia drummondii* that are restricted to semi-saline locations but also with species of more general distribution such as *Eucalyptus kessellii*. (Figure 3A)

Flowering period. The single known specimen had mature fruits and was also in late flower in mid October.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. *Astus duomilius* is known only from the type collection on crown land.

Etymology. The specific epithet is taken from the Latin *duo*—two and *milia*—thousand, to commemorate

the year 2000 when the first known collection of the new species was made.

Affinities. Differs from all other *Astus* species in the shape of its leaves and its habitat on a somewhat saline dune. It is closely related to *A. wittweri* but, apart from the major difference in its leaves, can be distinguished by its shorter peduncles and anthopodium, smaller flowers and fewer ovules.

Notes. In the small sample of fruits examined, there was usually a single seed in one of the dehiscent loculi and a single seed in the indehiscent loculus, giving a total seed set of two. One of the fruits appeared from external examination to be uniformly 3-locular, i.e. with three equally positioned dehiscent loculi. When dissected, however, it was found to have two dehiscent loculi less developed than usual because both lacked a mature seed, although one had a partially developed but aborted seed; the indehiscent loculus had a large mature seed protruding from the disc surface to a similar degree to the two under-developed dehiscent loculi.

Astus subroseus Trudgen & Rye, *sp. nov.*

Asto tetragono affinis sed floribus majoribus magis coloratis, foliis plerumque minoribus glandulis oleosis paucioribus differt.

Typus: Roe Location 2621, 32° 57' S, 118° 42' E, Western Australia, 6 Oct. 1997, J. & M. Stewart 30B (*holo:* PERTH 05038448; *iso:* CANB, MEL, PERTH).

Illustration. Rye & Trudgen (2005: Figure 1B–E).

Compact rounded *shrub*, 0.3–1.2 m tall, with many erect branchlets. *Leaves* appressed or antrorse, fairly crowded on the branchlets; petiole 0.1–0.5 mm long. *Leaf blades* obovate, 1–2 mm long, 0.8–1.2 mm wide, thickened, apex obtuse, margins often minutely denticulate; abaxial surface with an obvious keel especially towards apex, often produced into a small subterminal point, with large oil glands mostly in 1 or 2 rows on each side of keel, (1 row of oil glands in the youngest leaves on each branchlet but sometimes 2 rows on older leaves); adaxial surface with less prominent oil glands. *Inflorescence* of 1–3 pairs of flowers clustered at the tip of each branchlet. *Peduncles* 0.4–1.2 mm long. *Bracteoles* persistent, ovate to very broadly ovate, acutely keeled and with broad scarious margins, 0.6–1.7 mm long; apex acute to strongly incurved. *Anthopodium* 0.4–1.1 mm long. *Buds* with a highly raised apex. *Flowers* 5-merous but apparently up to 8-merous as a result of the combination of the 3 largest and most petaline calyx lobes with the 5 petals, pale to medium pink or purplish pink, 5–7 mm diam. *Hypanthium* obconic, 1.5–2.5 mm long, 2.0–2.8 mm diam., glandular and often very rugose between the ribs; free portion c. 0.6 mm long. *Calyx lobes* 5, slightly spreading to spreading, very unequal in length, 1.3–1.5 mm wide; largest calyx lobe petaline, broadly ovate, 1.5–1.8 mm long; smallest calyx lobe sepaline, depressed ovate, 0.7–1 mm long, with a prominent keel, incurved at apex, the outer surface deep pink (sometimes also with green) with a whitish margin, often slightly auriculate at base. *Petals* 5, more or less circular, 2–2.5 mm long. *Androecium* of 10(12) stamens, with 1–3 opposite each calyx lobe, with a filament 0.8–1.2 mm long; processes few, opposite calyx lobes, 0.05–0.15 mm long. *Anthers* 0.3–0.5 mm long; connective gland 0.1–0.2 mm diam. *Ovary* 3-locular, with two of the loculi broad and protruding at summit but not reaching base of ovary; third loculus not protruding at summit, reaching narrow base of ovary but overlapping the other two loculi for most of its length; ovules 2–5 (usually 3 or 4) per loculus, 2-toned with a dark-coloured strip adjacent to the placenta. *Style* 0.7–1.5 mm long; stigma nearly capitate to distinctly peltate, 0.15–0.2 mm diam. *Fruit* heart-shaped in outline, c. 2 × 1.8 mm, the summit 2-lobed, with 2 valvate terminal loculi (one in each lobe) and 1 non-valvate loculus at a lower level, without any spongy tissue, 1-seeded

as far as known; lobes extending *c.* 0.3 mm above the base of the free part of the hypanthium but deeper at centre of fruit; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; hypanthium very broadly obconic-obovoid, prominently ridged and rugose. *Viable seeds* broadly reniform, not seen fully mature but the largest seen *c.* 1.3 mm long, *c.* 0.8 mm thick, pale brown. *Insect-galled seeds* somewhat irregular in shape and patterning, 0.8–1.2 mm long, 0.4–0.6 mm wide, 0.6–0.7 mm thick, very pale brown; hilum compressed, 0.5–0.6 mm long, brown. (Figure 2A–F)

Selected specimens examined. WESTERN AUSTRALIA: 15 miles [24 km] E of Jurakin, near Bruce Rock, Sep. 1933, *E.T. Bailey* (PERTH); Muntagin, Sep. 1945, *E.T. Bailey* 212 (PERTH); *c.* 40 km S of Merredin on Narembreen road, 21 Aug. 1977, *B. Ballingall* (PERTH); Kalgarin turn off, 10.4 miles [16.7 km] W of Hyden, 9 Sep. 1966, *M. Barrow* M90 (PERTH); Woodline, 60 miles [97 km] S of Coolgardie, 3 Sep. 1926, *J.B. Cleland* (AD); Burngup Water Reserve, 9 Sep. 1996, *A.M. Coates* 4423 (CANB, NSW, PERTH); road to Bank Rock, 9 km W of junction with 'Eyre' Highway [Coolgardie–Norseman road], 14 Sep. 1989, *B.J. Conn* 3131 & *J.A. Scott* (PERTH); Lake Wagin, 1893, *Miss Cronin* (MEL); *s. loc.*, *J. Drummond* (MEL76286); 230 mile peg [370 km] on Menzies road [near Southern Cross], *J. Elliot* (PERTH); 20 miles [32 km] NW of Ravensthorpe, 14 Aug. 1925, *C.A. Gardner* 1769 (PERTH); *c.* 15 km SE of Londonderry Siding, 14 Sep. 1964, *R.H. Kuchel* 1766 (AD, PERTH); 30 km W of Kumarl, 10 Oct. 1966, *P.G. Wilson* 5680 (MEL, PERTH).

Distribution and habitat. Endemic to Western Australia, with most records from Wyalkatchem south-east to just north of Ravensthorpe, and with four records further east from the Coolgardie area to near Kumarl. At some localities *Astus subroseus* occurs on granitic rocks or on the apron of soil adjacent to granitic rock, but habitat details are not given for most collections. It occurs in a variety of soils including, well drained brown sandy loam, fine sand, reddish sand over clay, pale brown loamy sand over orange-brown gritty clay and pale brown sandy loam with lateritic gravel. *Astus subroseus* also occurs in a range of vegetation types, including *Eucalyptus* mallee shrubland, shrubland with emergent *Eucalyptus* mallee, and *Eucalyptus* woodland over low open shrubland. (Figure 3A)

Flowering period. Flowering from August to October. Fruits recorded in October. Mature fruits measured on *P.G. Wilson* 5680.

Conservation status. *Astus subroseus* is quite widespread, but a large part of its known range is located in the wheat belt, where clearing is extensive and environmental degradation ongoing. Searches of some older localities by the authors (Merredin area, Bruce Rock) did not relocate *Astus subroseus* at those places, although the searches were not exhaustive. The authors did locate one new population, but this was quite small. In the wheatbelt part of its range this species is known from three small reserves (Burngup Water Reserve, Wogarl Townsite Reserve and Water Reserve 19014 west of Wyalkatchem). It is likely that in the wheat belt part of its range *Astus subroseus* will be reduced to occurring in such reserves. However, it is also known from the goldfields, although only from three collections. It is probable that the small number of collections from the goldfields indicates lack of collecting, rather than indicating true levels of occurrence.

Etymology. The specific epithet refers to the pink colour of the flowers, which varies from very pale to fairly deep in intensity.

Affinities and notes. This species has previously been known by the informal name *Baeckea* sp. Burngup (*A.M. Coates* 4423). It is very closely related to *A. tetragonus*, differing in its usually smaller leaves with fewer rows of oil glands, its larger and more colourful flowers, and its usually fewer and shorter processes.

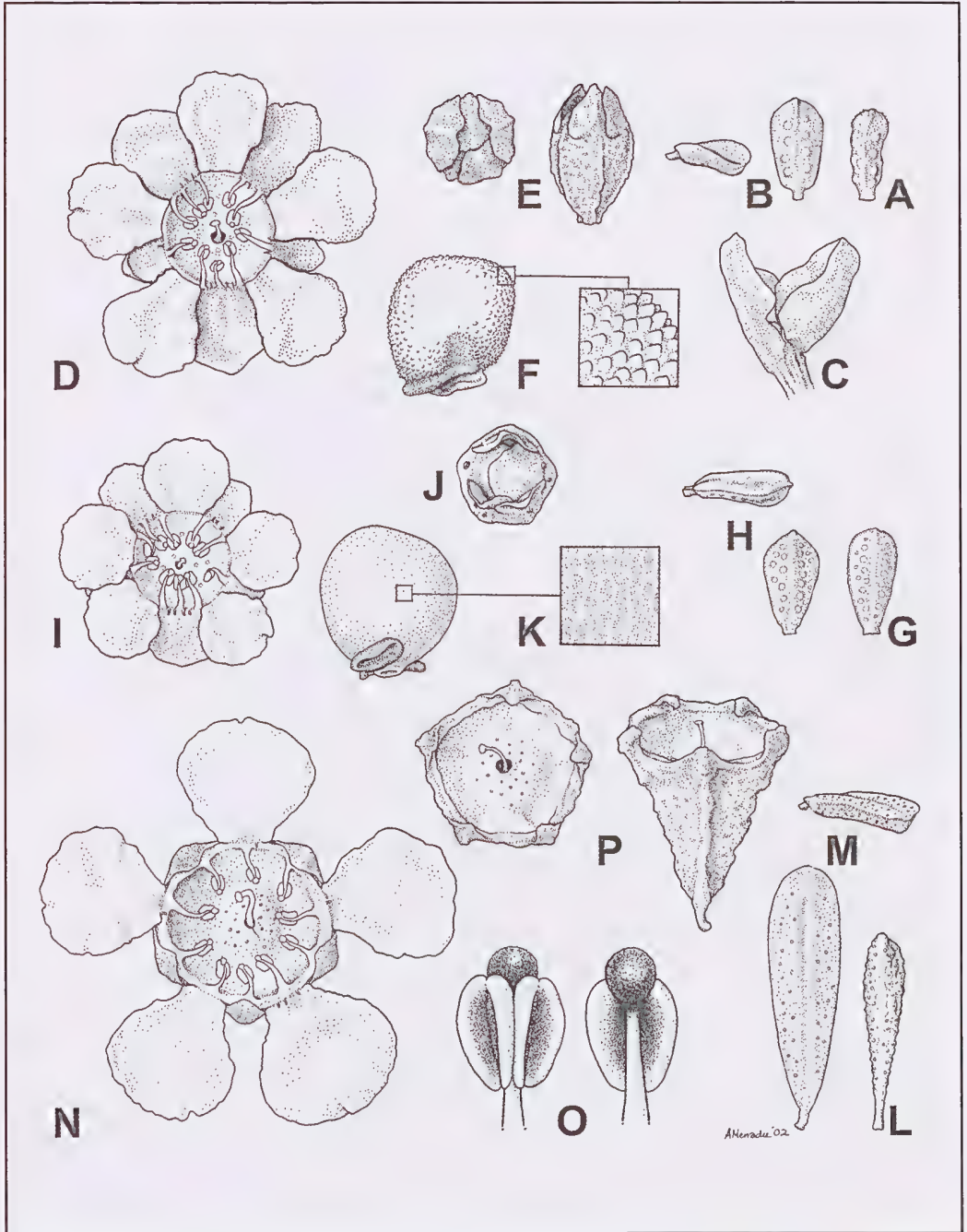


Figure 2. A-F. *Astus subroseus*. A - juvenile leaf ($\times 10$), B - two views of adult leaf ($\times 10$), C - peduncle and bracteoles ($\times 15$), D - flower ($\times 7.5$), E - top and side view of fruit ($\times 7.5$), F - insect-galled seed ($\times 20$); G-K. *Astus tetragonus*. G - juvenile leaf ($\times 10$), H - two views of adult leaf ($\times 10$), I - flower ($\times 7.5$), J - top view of fruit ($\times 10$), K - insect-galled seed and chaff pieces ($\times 30$); L-P. *Astus wittveri*. L - juvenile leaf ($\times 7.5$), M - two views of adult leaf ($\times 7.5$), N - flower ($\times 7.5$), O - two views of stamen ($\times 50$), P - top and side view of young fruit ($\times 8$). Drawn by Annemarie Menadue from A.M. Coates 4423 (A-D), Paul G. Wilson 5680 (E,F), R. Spjut et al. 7333 (G-I), R.J. Hnatiuk 761163 (J,K), A.S. George 16135 (L-O) and M.G. Brooker 3722 (P).

Astus tetragonus (F. Muell. ex Benth.) Trudgen & Rye, *comb. nov.*

Baeckea tetragona F. Muell. ex Benth., Fl. Austral. 3, 77 (1867). *Type*: Middle Mt Barren, [Western Australia], G. Maxwell (*lecto*: MEL 73059, here designated). *Other material*: Lucky Bay, [Western Australia], January 1802, R. Brown (*lectopara*: BM 000603459); east of King George Sound, [Western Australia], 1828–1829, W. Baxter (*lectopara*: n.v.).

Illustration. Blackall & Grieve (1980: 70) [as *Baeckea tetragona*]; Rye & Trudgen (2005: Figure 1F).

Dense *shrub*, 0.3–1.5 m tall, with many erect branchlets. *Leaves* moderately spreading, crowded on branchlets; petiole 0.3–1 mm long. *Leafblades* obovate to broadly elliptic, 1.3–3.2 mm long, 1.0–1.3 mm wide, thick, apex obtuse; abaxial surface with a distinct keel especially towards apex, often produced into a minute subterminal point; abaxial surface with moderately large oil glands usually in 2 or 3 main rows on each side of keel; adaxial surface with less prominent oil glands. *Inflorescence* of 2–5 pairs of flowers clustered at tip of each branchlet or at the base of new growth. *Peduncles* usually 0.6–0.8 mm long. *Bracteoles* persistent, ovate or broadly ovate, with an acute herbaceous keel and broad scarious margins, 0.9–1.5 mm long. *Anthopodium* absent or up to 0.7 mm long. *Buds* with a highly raised apex. *Flowers* 5-merous but apparently 6–8-merous as a result of the combination of the 3 largest and most petaline calyx lobes with the 5 petals, white or possibly rarely very pale pink, 3–5 mm diam. *Hypanthium* obconic to hemispheric, 1.0–2.5 mm long, 1.5–2.5 mm diam., glandular-rugose; free portion c. 0.5 mm long. *Calyx lobes* 5, moderately spreading, very unequal, of two intergrading kinds, 1.0–1.2 mm wide, often pink-tinged outside; largest calyx lobe petaline, semi-elliptic, 1.3–1.8 mm long; smallest calyx lobe sepaline, 0.6–1.0 mm long, with a central thickened herbaceous band. *Petals* 5, spreading, scarcely clawed, more or less circular, 1.3–2 mm long. *Androecium* of 8–10 (usually 10) stamens, 1–3 opposite each calyx lobe, with a filament 0.5–1.2 mm long; processes few or many, opposite the calyx lobes, 0.15–0.3 mm long. *Anthers* 0.3–0.5 mm long; connective gland 0.1–0.2 mm diam. *Ovary* 2–4-locular, usually 3-locular, with 1 or 2 loculi reduced, flat-topped; ovules 4–6 in at least one loculus, often 1 or absent in reduced loculi, often 2-toned with a dark-coloured strip adjacent to the placenta. *Style* 0.5–1.5 mm long; stigma peltate, 0.15–0.2 mm diam. *Fruit* very irregularly obconic, c. 1.7 mm long, c. 1.4 mm wide, apparently flat-topped, without any spongy tissue, 1-seeded as far as known; hypanthium broadly obconic, irregularly swollen on one side or towards base, glandular-rugose and ribbed. Viable seeds (possibly not seen at full maturity) broadly reniform, c. 1.2 mm long, c. 0.6 mm wide, c. 0.65 mm thick, pale brown. *Insect-galled seeds* almost globular, c. 0.8 mm long, c. 0.6 mm wide, c. 0.7 mm thick; testa very pale golden brown, minutely reticulate; hilum small. (Figures 1, 2G–K)

Selected specimens examined. WESTERN AUSTRALIA: Mt Ridley, K.M. Allen 365 (CANB, MEL, NSW, P, PERTH); Lake Wagin, 1893, Miss Cronin (MEL); Cape Riche, 9 Oct. 1928, C.A. Gardner 2148 (PERTH); junction of Fitzgerald and Susetta Rivers, Fitzgerald River National Park, 34°01'S, 119°27'E, 12 July 1970, A.S. George 9969 (PERTH); 58 km W of Point Malcolm, 20 Sep. 1976, R.J. Hnatiuk 761163 (PERTH); near summit of Mt Burdett, 4 Oct. 1968, E.N.S. Jackson 1320 (AD); near East Mt Barren estuary, G. Maxwell (BM000603460); Needilup Hill, 16 Aug. 1964, K.R. Newbey 1349 (PERTH); Lort River, near crossing of the Esperance–Ravensthorpe road, 9 Oct. 1968, A.E. Orchard 1428 (AD, PERTH); on a granite hill N of South Coast Highway, 33.5 km E of Ravensthorpe, 12 Dec. 2003, B.L. Rye 231255 (CANB, MEL, PERTH); 115 km ENE of Esperance, 1 Oct. 1970, R.A. Saffrey 1250 (AD, CANB, MEL, PERTH); Mt Howick, 29 Apr. 1968, Paul G. Wilson 8130 (K, MEL, NSW, PERTH); 2.3 km N of Maringerup Rd, South Coast Highway, 23 Oct. 1997, Peter G. Wilson 1435 & N. Lam (NSW n.v., UNSW n.v., PERTH); Cape Le Grand, 30 Oct. 1968, J. Wrigley 030920 (BRI, CBG, NSW, PERTH).

Distribution and habitat. Endemic to Western Australia, found in a belt along the south coast from Cape Riche to 115 km east-north-east of Esperance and inland to Needilup Hill and Mt Ragged. *Astus tetragonus* is commonly found on granitic rocks over almost all of its range, but at Cape Riche grows on sandstone, and one collection was described as coming from soil with "underlying geology saline and gypsiferous clay and silt in playa lake deposits". This species grows in a variety of soil types, including sandy soil on granite, loam on granite, brown sandy loam and sandy gravel. It also occurs in a range of vegetation types including low open *Eucalyptus* woodland, *Allocasuarina campestris* thicket, and open heath. It often occurs with a variety of granite-associated species. (Figure 3B)

Flowering period. Flowering specimens have been collected from August to early November. Mature fruits observed on *R.J. Hnatiuk* 761163. Seeds measured from *R. Meissner* LB164.

Conservation status. This species has a fairly wide range along the south coast and is found in three large national parks. Its conservation status is probably secure.

Typification. The specimen selected as the lectotype has a corner of the label folded down with the letter B written on the reverse side, indicating that Bentham examined this specimen. One of the two excluded syntypes, cited as "E of King George's Sound, Baxter", was not located in this study.

Affinities. See notes under *Astus subroseus*.

Notes. Normally this species has ten stamens in a circle in groups in the sequence 1,2,3,1,3 with a solitary stamen opposite the centre of each of the two smallest calyx lobes, two lateral stamens opposite the medium-sized calyx lobe and three stamens (one central and two lateral) opposite each of the largest two calyx lobes. A similar arrangement of 10 stamens has been observed in many unrelated species such as *Ahuta aspera* Rye & Trudgen (Rye & Trudgen 2000: Figure 3L), *Baeckea elderiana* E. Pritz. and a close relative of *Baeckea robusta* F. Muell. (Rye 1987: Figure 142C), but these taxa show much less variation in calyx lobe size. A few specimens of *A. tetragonus* (e.g. *R.A. Saffrey* 1250) with very small flowers appear to have a variable number of stamens from 8 to 10, those with 9 stamens having the arrangement 1,2,2,1,3 and those with 8 stamens having only 2 stamens opposite each of the inner calyx lobes.

At coastal locations *Astus tetragonus* can occur on headlands facing the ocean, when it is wind-pruned and presumably tolerant to salt carried by the wind. On more sheltered sites on granite hills further inland it can reach 1 metre in height, but still with a dense habit.

Astus wittveri* Trudgen & Rye, *sp. nov.

Asto duomilio affinis sed foliis latoribus, anthopodo et floribus majoribus, et ovulis plus numerosissimis differt.

Typus: Lower part of Mt Ragged, Western Australia, 16 Nov. 1976, *E. Wittwer* W1898 (*holo:* PERTH 06735878; *iso:* KPBG, PERTH 06790127).

Illustration. Rye & Trudgen (2005: Figure 1G).

Shrub 0.5–2 m tall, with short leafy branchlets on long stems. *Leaves* antrorse to almost patent, crowded on the branchlets, separated on lower stems; petiole 0.5–1 mm long; lamina obovate, 2.2–4.2

mm long, 1.2–1.6 mm wide, somewhat thickened but without an obvious keel, apex obtuse, abaxial surface smooth, oil glands abundant on both surfaces and in many rows across the lamina. *Inflorescence* usually of 3–8(15) pairs of flowers clustered at tip of each branchlet. *Peduncles* 0.6–0.9 mm long. *Bracteoles* caducous (present on young buds only), subulate, 1.6–2 mm long, 0.5–0.6 mm wide. *Anthopodium* 1.5–2 mm long. *Buds* 5-lobed around a concave apex. *Flowers* (4)5-merous, 7.5–9 mm diam. *Hypanthium* obconic or broadly obconic, 2–4.5 mm long, 4–5 mm diam., glandular but scarcely rugose; free portion 1–1.4 mm long. *Calyx lobes* (4)5, all of a similar size, very depressed, 0.4–0.5 mm long, 1.5–2 mm wide, strongly incurved at apex, with a very thickened herbaceous keel and scarious lateral margins, the innermost calyx lobe often with the scarious margin extending around the apex. *Petals* (4)5, widely spreading, scarcely clawed, subcircular, 2.5–3.6 mm long, white. *Androecium*: stamens usually 10, one opposite each petal and calyx lobe, rarely 8 (in 4-merous flowers), the antipetalous ones with a filament 0.9–1.0 mm long, the antisepalous ones tending to be shorter, with a filament 0.6–0.9 mm long; processes few, opposite the petals, 0.05–0.2 mm long. *Anthers* 0.4–0.6 mm long; connective gland 0.2–0.4 mm diam. *Ovary* 3(4)-locular, the indehiscent loculus reduced in size; ovules in two valvate loculi 4–7 (usually 6), in non-valvate loculus 1 or rarely 2–4, uniformly coloured or sometimes somewhat 2-toned. *Style* 1.3–2.3 mm long; stigma peltate, 0.3–0.4 mm diam. *Fruit* heart-shaped in outline, c. 2.5 x 2.2 mm, with summit prominently 2-lobed, each lobe corresponding with one of the 2 valvate loculi, the non-valvate loculus of a similar volume but more compressed, the remainder of the fruit (at the base and extending up one side) with a very open reticulum of spongy tissue; indehiscent loculus to one side of fruit, its summit reaching the base of the lobes; lobes extending c. 0.6 mm above the base of the free part of the hypanthium but deeper at centre of fruit; hypanthium broadly obconic-obovoid, glandular but without obvious ribs when fully mature. *Seeds* reniform-obovoid, (1) 1.2–1.6 mm long, c. 0.5 mm wide, 0.6–0.7 mm thick, medium brown. (Figure 2L–P)

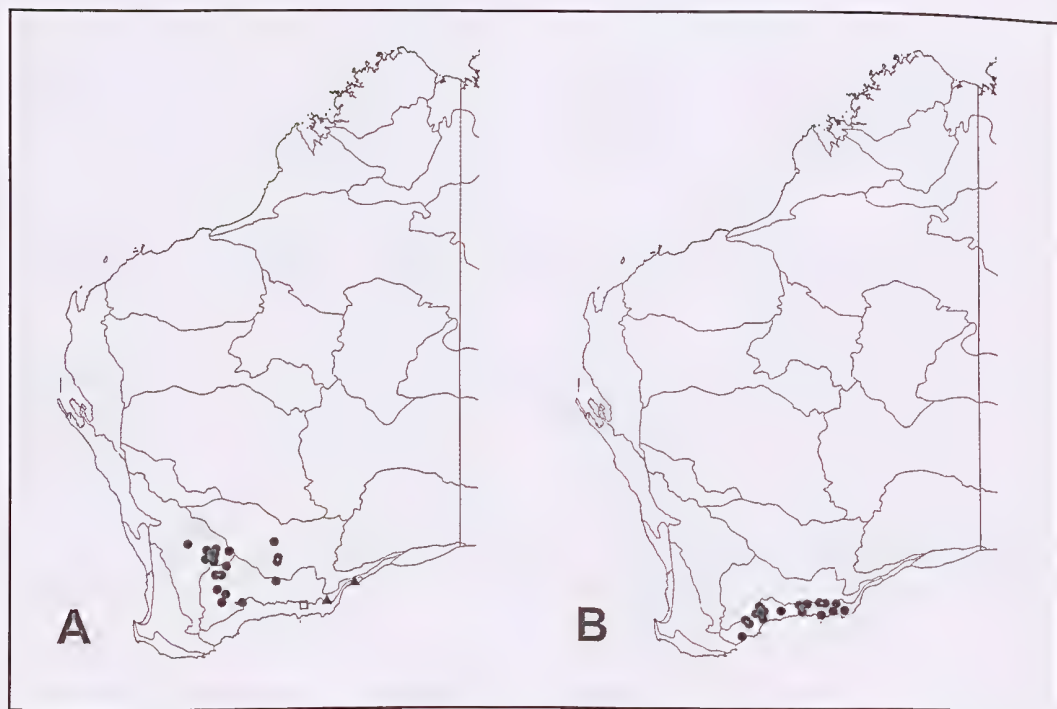


Figure 3. Distribution maps. A – *Astus duomilius* □, *A. subroseus* ● and *A. wittveri* ▲; B – *Astus tetragonus* ●.

Other specimens examined. WESTERNAUSTRALIA: 10 miles [16 km] W of Pt Culver, 30 Oct. 1973, *M.G. Brooker* 3722 (PERTH); Tower Peak [Mt Ragged], 17 Aug. 1980, *A.S. George* 16135 (PERTH); Mt Ragged, near base, 17 Aug. 1980, *M.A. Clements* 2049 (CBG).

Distribution and habitat. Endemic to Western Australia, known from Mt Ragged and near Point Culver. *Astus wittveri* has been recorded on sand at the base of cliffs or among quartzite rocks on the lower slopes of a rocky ridge, in vegetation variously described as 'mallee shrubland with *Eucalyptus tetraptera* dominant', 'mallee' and 'low shrubland'. (Figure 3A)

Flowering period. Flowering recorded from August to mid November. Fruits recorded late October and November. Fruits and seeds measured on *M.G. Brooker* 3722 and *E. Wittwer* W1898.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. *Astus wittveri* is only known from four collections, three of these in the vicinity of Mount Ragged in Cape Arid National Park, and the other more than 100 km north-east in Nuytsland Nature Reserve. Both areas are apparently well protected but this poorly known species needs to be surveyed to assess its conservation status better.

Etymology. The specific epithet is in honour of Ernst Wittwer, Nurseryman and Superintendent at Kings Park and Botanic Gardens. Ernst collected widely in the State and collected the material used for the type of this species.

Affinities. *Astus wittveri* has the broadest leaves and largest flowers in the genus. Its seeds are possibly more deeply colliculate than those of the other species, with the numerous cells deeply convex. It is closely related to *A. duomilius*, differing as described under that species.

Notes. Occasionally a few 4-merous flowers are produced. The buds have a flat top with the fleshy keels of the incurved calyx lobes forming a five-pointed crown around the edge. Usually several seeds are produced in each of the dehiscent loculi and a single seed in the indehiscent loculus.

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References

- Bean, A.R. (1995). Reinstatement and revision of *Triplarina* Raf. (Myrtaceae). *Austrobaileya* 4: 353–367.
- Bean, A.R. (1995). A new species and new combination in *Ochrosperma* Trudgen (Myrtaceae). *Austrobaileya* 4: 387–390.
- Beard, J.S. (1980). A new phytogeographic map of Western Australia. *Western Australian Herbarium Research Notes* 3: 37–58.
- Bentham, G. (1867). "Flora Australiensis." Vol. 3. (Lovell Reeve & Co.: London.)
- Blackall, W.E. & Grieve, B.J. (1980). "How to Know Western Australian Wildflowers." Part 3A. Revised 2nd ed. by B.J. Grieve. (University of Western Australia Press: Nedlands.)
- Briggs, B.G. & Johnson, L.A.S. (1979). Evolution in the Myrtaceae – evidence from inflorescence structure. *Proceedings of the Linnean Society of New South Wales* 102(4): 157–256.
- Johnson, L.A.S. & Briggs, B.G. (1979). Myrtales and Myrtaceae – a phylogenetic analysis. *Annals of the Missouri Botanical Garden* 71: 700–756.
- Lam, N., Wilson, Peter G., Heslewood, M.M. & Quinn, C.J. (2002). A phylogenetic analysis of the *Chamelaucium* alliance (Myrtaceae). *Australian Systematic Botany* 15: 535–543.
- Niedenzu, F. (1893). Myrtaceae. In: Engler, A. & Prantl, K. (eds) "Die Natürlichen Pflanzenfamilien." Vol. 3(7), 57–105. (Engelmann: Leipzig.)
- Rye, B.L. (1987). Myrtaceae. In: "Flora of the Perth Region." Vol. 1, pp. 377–429.
- Rye, B.L. & James, S.H. (1992). The relationship between dysploidy and reproductive capacity in Myrtaceae. *Australian Journal of Botany* 40: 829–848.
- Rye, B.L. & Trudgen, M.E. (2000). *Aluta*, a new Australian genus of Myrtaceae. *Nuytsia* 13: 345–366.
- Rye, B.L. & Trudgen, M.E. (2005). A new heterocarpidic fruit type for the Myrtaceae, with dehiscent and indehiscent loculi, in two genera from Western Australia. *Nuytsia* 15: 485–493.
- Thackway, R. & Cresswell, I.D. (1995). (eds) An interim biogeographic regionalisation for Australia: a framework for establishing the national system of reserves, version 4.0. Published Report of the Australian Nature Conservation Agency: Canberra.
- Trudgen, M.E. (1986). Reinstatement and revision of *Rinzia* Schauer (Myrtaceae). *Nuytsia* 5: 415–439.
- Trudgen, M.E. (1987). *Ochrosperma*, a new genus of Myrtaceae (Leptospermeae, Baeckeinae) from New South Wales and Queensland. *Nuytsia* 6: 9–17.
- Trudgen, M.E. (2001). Reinstatement and revision of *Euryomyrtus* (Myrtaceae). *Nuytsia* 13: 543–566.
- Wilson, P.G., O'Brien, M.M., Heslewood, M.M. & Quinn, C.J. (2005). Relationships within Myrtaceae sensu lato based on a matK phylogeny. *Plant Systematics and Evolution* 251: 3–19.